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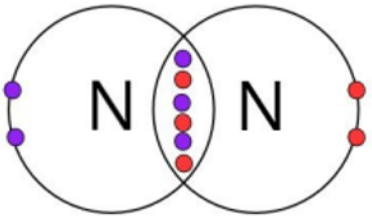
# CHAPTER 12: NITROGEN AND SULFUR

## Nitrogen gas:

- Nitrogen gas is a stable molecule, hence unreactive due to:
  - Strong triple bond + short bond length
  - Non-polar/ does not have a permanent dipole

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## Atmospheric production of $NO_2$:

- Lightning strikes provides enough energy to cause $N_2$ to react with $O_2$:
  - $N_2 + O_2 \rightarrow 2NO$
  - $2NO + O_2 \rightarrow 2NO_2$

## Nitrogen compounds:

- Unlike nitrogen gas, nitrogen-containing compounds often react with other chemicals
  - Nitrogen oxides
  - Ammonium compounds
  - Ammonia

## Formation of acid rain by $NO_2$:

- $NO_2$ can react with water to form acid rain
  - $2NO_2 + H_2O + ½O_2 \rightarrow 2HNO_3$
- $NO_2$ can also catalyse the formation of $SO_3$ in the atmosphere
  - Leading to $H_2SO_4$ production in rainwater
  - $SO_2(g) + NO_2(g) \rightarrow SO_3(g) + NO(g)$
  - $NO(g) + ½O_2(g) \rightarrow NO_2(g)$ [$NO_2$ is regenerated]
  - $SO_3 + H_2O \rightarrow H_2SO_4$

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**Reducing $NO_x$ pollution:**

- Catalytic converters in cars reduce/ decompose $NO_x$:
  - $2NO_2 + 4CO \rightarrow N_2 + 4CO_2$

    Or
  - $2NO + 2CO \rightarrow N_2 + 2CO_2$
  - Catalyst: platinum, Pt

**Reaction of ammonium compounds:**

- $NH_4^+$ ions can react with hydroxides to form $NH_3$:
  - $Ca(OH)_2(s) + 2NH_4Cl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l) + 2NH_3(g)$

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**Environmental impact of ammonia:**

- Excessive use of ammonia as fertilizers result in the eutrophication of water bodies:
  - Fertilizers are leached out into rivers
  - Algae grows uncontrollably AND sunlight is blocked out/ aquatic plants can no longer carry out photosynthesis
  - Oxygen concentration decreases

## Sulfur

### Formation of Sulfur Dioxide

Sulfur dioxide is formed when fossil fuels, containing sulfur impurities, are burnt in oxygen.

$$S + O_2 \rightarrow SO_2$$

### Acid Rain

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Sulfur dioxide reacts with oxygen in the atmosphere to form sulfur trioxide. When sulfur trioxide is dissolved in water vapour in clouds, acid rain is produced. Acid rain causes environmental damage such as:

- Corrosion of limestone buildings and statues.
- Acidification of lakes and rivers, damaging the ecosystems in the water.
- Damage to vegetation.

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